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Missouri School of Mines.

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Catalogue.

1895-6.

Mo. Sch. of Mines
1895-6

"WORK IS VICTORY."

— *Emerson.*

Twenty-fifth Annual Catalogue

of the

School of Mines and Metallurgy

of the

University of the State of Missouri,

Rolla, Missouri.

1896.

St. Louis:
Nixon-Jones Printing Co.
1896.

Calendar.

1896.

June 11, Thursday, 10 A. M. ..... Annual Commencement.
September 14, Monday, 10 A. M. ..... Entrance Examination.
September 15, Tuesday ..... First Term Begins.
November 26, Thursday ..... Thanksgiving Holiday.
December 24, Thursday ..... Christmas Holidays Begin.

1897.

January 5, Tuesday ..... Exercises Resumed.
January 25, Monday ..... Mid-year Examinations Begin.
February 2, Tuesday ..... Second Term Begins.
February 22, Monday ..... Washington's Birthday Holiday.
May 31, Monday ..... Final Examinations Begin.
June 8, Tuesday ..... Final Examinations Close.
June 10, Thursday, 10 A. M. ..... Annual Commencement.

Club House. Chemical Laboratory. Main Building.

Board of Curators

of the

University of the State of Missouri

Term expires January 1, 1897.

Prof. C. M. Woodward - - -	St. Louis.
Hon. Nat. M. Shelton - - -	Lancaster.
Hon. W. M. Eads - - -	Carrollton.

Term expires January 1, 1899.

Hon. R. B. Oliver - - - -	Jackson.
G. B. Rollins, Esq. - - -	Columbia.
Hon. Jas. T. Moore - - -	Lebanon.

Term expires January 1, 1901.

Gardiner Lathrop, Esq. - -	Kansas City.
B. R. Cauthorn, Esq. - - -	Mexico.
Hon. M. E. Benton - - -	Neosho.

OFFICERS OF THE BOARD.

C. M. Woodward - - - -	President.
Nat. M. Shelton - - -	Vice-president.
J. G. Babb - - - - -	Secretary.
R. B. Price - - - -	Treasurer.

Executive Committee

of the

School of Mines and Metallurgy.

R. B. Oliver - - - -	Jackson.
M. E. Benton - - - -	Neosho.
C. M. Woodward - - -	St. Louis.

OFFICERS OF THE COMMITTEE.

R. B. Oliver - - - - -	Chairman.
M. F. Faulkner - - - -	Secretary.
D. W. Malcolm - - - -	Treasurer.

Faculty.

RICHARD H. JESSE, LL.D. - *President of the University.*

WALTER BUCK RICHARDS, M. A.,
Director and Professor of Mathematics.
M. A., University of Virginia, 1885.

ELMO G. HARRIS, C. E. - . *Professor of Engineering.*
C. E., University of Virginia, 1882.

COURTENAY DE KALB - *Professor of Mining and Metallurgy.*

ARTHUR H. TIMMERMAN, M. M. E., *Professor of Physics.*
B. S., College of City of N. Y., 1891;
M. M. E., Cornell University, 1893.

EUGENE T. ALLEN, PH. D. - - *Professor of Chemistry.*
A. B., Amherst College, 1887; Ph. D., Johns Hopkins University, 1892.

PAUL J. WILKINS, B. S., *Instructor in Academic Department.*
B. S., Michigan A. & M. College, 1869.

THOMAS L. RUBEY, A. M., *Secretary, and Instructor in English.*
A. M., University of Missouri, 1885.

GEORGE E. MILLER, B. S., *Instructor in Shopwork and Drawing.*
B. S., University of Missouri, 1895.

PAUL A. LARSH - - *Assistant in Chemical Laboratory.*
Missouri School of Mines.

Administrative Officers.

RICHARD H. JESSE,
President of the University.

WALTER B. RICHARDS,
Director of the School of Mines.

THOMAS L. RUBEY,
Librarian and Secretary of the Faculty.

History.

In 1870 the General Assembly of Missouri in accepting the donation of land for educational purposes made by the general government through Act of Congress, approved July 2, 1862, established an Agricultural and Mechanical College and a School of Mines and Metallurgy. The design of these institutions is set forth in the following language: —

Objects of these Colleges. — The leading objects of said colleges shall be to teach such branches as are related to agriculture and the mechanic arts and mining, including military tactics, and without excluding other scientific and classical studies, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life. (R. S. 1889, Sec. 8739.)

The Agricultural and Mechanical College was located in Boone County; the School of Mines and Metallurgy was to be located in that county of Southern Missouri which should offer the greatest inducements for such location. A commission was appointed to receive and pass upon proposals looking to this, and after mature investigation and deliberation pronounced in favor of Phelps County. Here in the next year (1871), the School of Mines began its active existence.

The statutes fix the *status* of the School as one of the colleges of the State University. Its affairs are immediately under the supervision of an Executive Committee, consisting of three members of the University Board of Curators elected by that body.

The need of a general culture as a foundation and accompaniment of specifically technical training and the prevailing

absence of facilities for gaining this from the reach of the intended beneficiaries of the institution led to the establishment in 1885 of an Academic Course in compliance with the following Act of Assembly :—

Academic Course of Study, etc.— That the obligations of the State to the general government, assumed by the acceptance of the land grant of July 2, 1862, may be more fully discharged, and in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life, the Board of Curators of the State University shall prescribe and adopt a liberal Academic Course of Study to be taught in the College of Mines and Metallurgy, located at Rolla, in addition to the courses now taught in said school, and may confer the degree of Bachelor of Science upon all students who shall complete said course in said school to the satisfaction of the faculty thereof. (R. S., Sec. 8740.)

The School of Mines is organized and conducted with a view to subserving, as efficiently as possible, the ends set forth in the legislative enactments in reference to it.

Finances.

The proceeds from the sale of the public lands, the grant of which has been referred to, amounts to $332,000, which is invested in State certificates of indebtedness bearing 5 per cent. interest. The School of Mines receives one-fourth of the yearly income thus accruing. By an act of Congress approved August 30th, 1890, commonly known as the "Morrill Bill," the general government donated to each State and

territory, maintaining a college or colleges in accordance with the act of July 2d, 1862, $15,000 for the year 1889–90 which should be increased by $1,000 a year until the donation should reach $25,000 a year, this to remain thenceforth an annual appropriation. After deducting one-sixteenth of this fund for the Lincoln Institute, Missouri gives one-fourth of the remainder to the School of Mines.

In 1891, the government returned to the various States the sums collected from their citizens by the imposition during the Civil War of a "direct tax." The amount thus refunded to Missouri was $646,958.33, and the 36th General Assembly of the State won the gratitude of the friends of the higher education by establishing this as a permanent endowment for the State University, specifically designating one-fifth as the portion of the income from this source which should belong to the School of Mines. The investment of the fund in 5 per cent. State certificates yields to the school annually $6,469,58.

From these three sources, then, the school enjoys an annual revenue of somewhat more than $15,000. Such additional sums as are necessary for its support are furnished by biennial legislative appropriations.

Location.

The School of Mines is situated at Rolla, the county seat of Phelps County. Rolla is a town of about 2,000 inhabitants on the St. Louis and San Francisco R. R., approximately half way between St. Louis and Springfield. It has an elevation of 1,140 feet above the sea level, and enjoys an agreeable and

notably healthful climate. Not infrequently families from less favored climates move hither, seeking at once the health of the older members, the education of the younger. Its position on a great transcontinental railway system (the "Santa Fé") renders it readily accessible from all quarters. It is within easy reach of the lead and zinc district of the southwest, and of the lead and iron regions of the southeast, while opportunities to observe processes of mining and smelting the latter ores are close at hand. Visits of inspection to these mining fields are expected to be an important means of instruction.

The Senior class in Metallurgy took last year, for this purpose, a trip which proved highly interesting and instructive. It included visits to the smelters in Belleville, Illinois, the mines at Bonne Terre, the smelting works at Herculaneum, and the Tudor Iron Works in St. Louis. The thanks of the School are due to the officials in charge of these plants for their courtesies.

Technical Courses.

PLAN OF INSTRUCTION.

It is the object of the instruction at this institution, first, to lay a broad and solid foundation in the way of acquaintance with principles and theory, and to supplement this, wherever possible, by the discipline of practical application in the laboratory and the field. Lectures and recitations are arranged to come in the morning hours, leaving the afternoon for laboratory and field work. This practical work is designed to illustrate and impress principles, to familiarize with the use of instruments and apparatus, to give valuable

experience in operations with which the student is to be concerned in the work of his profession, and to afford an opportunity for original investigation. With additions now making, the school will be excellently provided with laboratories and equipment, of which it makes a large use.

Each applicant for a degree is required during his Senior year to present to the Faculty a Thesis, recording the result of some original investigation or independent research in a subject connected with his course. It must be accompanied with any drawings that may be necessary to illustrate it, and a copy of it must be deposited with the Librarian for preservation. The acceptance of this Thesis as satisfactory is a condition of graduation.

ADMISSION.

Persons of both sexes, sixteen years of age or over, whether residents of the State or non-residents, may be admitted upon evidence of sufficient preparation. The entrance requirements — which are confessedly not high — have been fixed through considerations of the express design of the school "to promote the education of the industrial classes," and of the educational opportunities of those whose interests were chiefly contemplated in its establishment. The importance in scientific education of the fundamental branches of Mathematics and a frequently observed lack on the part of applicants of thoroughness in them has led to the inclusion of Algebra, Geometry and Elementary Physics in the work of the Freshman year. It has seemed better to teach these subjects than to let the student proceed with insufficient knowledge of them, or to exclude otherwise worthy applicants for delinquency due in many cases to lack

of opportunity. At the same time, with the development of our public school system and a perceptible rise in the grade of our entering students, it is hoped that it may soon be feasible to advance the conditions of admission. At present to enter the Freshman Class a knowledge of English Grammar and Composition, Arithmetic, and Elementary Algebra as far as Quadratic equations is necessary.

Following is a list of Schools whose courses have been approved by the University, and whose diplomas will admit to the Freshman Class without examination. By an order of the Board of Curators the student who obtains the highest rank in the graduating class of any of these schools will be admitted without the payment for the first year of the usual entrance fee.

NAME OF SCHOOL.	SUPERINTENDENT AND PRINCIPAL.
Appleton City Academy	G A. Thielman.
Bethany High School	J. R. Hale.
Bolivar High School	C. T. Wright.
Brookfield College	M. H. Reaser.
Buchanan College, Troy, Mo	Wm. F. Roberts.
Cameron High School	B. Riggs. Miss Bertha Ensign.
Carrollton High School	L. W. Roder. Mrs. R. R. Quisenberry.
Carthage High School	W. J. Stevens. E. E. Dodd.
Chillicothe High School	W. F. Jamison. E. E. Stout.
Columbia High School	R. H. Emberson.
Ft. Smith High School, Ft. Smith, Ark	J. L. Holloway.
Hannibal High School	R. B. Simonson. Miss Gertrude Ashmore.
Harrisonville High School	A. F. Treakle.
Higginsville High School	H. B. Walker.
Independence High School	Wm. F. Bahlman. Wm. L. C. Palmer.

Joplin High School..... { W. B. Brown. J. D. Eliff.
Kansas City High School..... { J. M. Greenwood. John T. Buchanan.
Kemper Family School, Boonville, Mo.....T. A. Johnson.
Lamar High School.....W. H. Martin.
Lancaster High School.....W. C. Thompson.
Louisiana High School..... { A. P. Settle. R. R. Rowley.
Marmaduke Military Academy, Sweet Springs, Mo.
Marshall High School..... { T. E. Spencer. C. A. Snodgrass.
Maryville High School..... { A. E. Clarendon. B. F. Duncan.
Marionville Collegiate Institute, Marionville, Mo. M. L. Curl.
Mexico High School..... { D. A. McMilton. O. K. Brown.
Miami High School.....E. E. Barnett.
Michigan Military Academy, Orchard Lake, Mich. W. H. Butts.
Missouri Military Academy, Mexico, Mo.....A. F. Fleet.
Moberly High School..... { H. H. Holmes. J. A. Whiteford.
Monroe City High School.....R. S. Nichols.
Mound City High School.....J. P. Coleman.
Mountain Grove Academy, Mountain Grove, Mo. L. R. Griffin.
Mt. Vernon Academy, Mt. Vernon, Mo.....G. H. Pollard.
Nevada High School.....W. J. Hawkins.
Paris High School.....W. D. Christian.
Richmond High School..... { J. M. Baily. J. E. Dunn.
Rockport High Schools.....B. F. Brown.
Sedalia High School..... { G. V. Buchanan. J. D. Wilson.
Shelbina High School.....J. T. Vaughn.
Slater High School.....G. W. Newton.
Springfield High School..... { J. Fairbanks. W. T. Carrington.
St. Joseph High School..... { Edward B. Neely. C. E. Miller.
St. James Military Academy, Macon City, Mo.....F. W. Blees.

St. Louis High School..... { F. Louis Soldan. / W. J. S. Bryan.
Trenton High School..... { H. E. DuBois. / E. M. Painter.
University Academy, Columbia, Mo.....Herman F. Harris.
Wentworth Military Academy, Lexington, Mo...Sanford Sellers.
Westport High School..... { S. A. Underwood. / Sarah E. Steele.

Candidates may be admitted to "advanced standing" (that is to enter the Sophomore or the Junior class) either upon examination in the subjects of the previous year or years, or upon certificate from another institution of work in the estimation of the Faculty fairly equivalent to that done here by the class into which entrance is sought. Applicants for advanced standing should communicate with the Director as early as possible.

Courses of Study.

The School of Mines offers three complete Technical Courses, extending through four years, viz. :—

I. Mining Engineering.
II. Civil Engineering.
III. Chemistry and Metallurgy.

Course I. is a general course in Mining Engineering, having in view all the operations in connection with mining,

* Where two names are given the first is that of the Superintendent and the second that of the Principal.

from the prospecting for the mine to the delivery of the finished product on the market.

Course II. is a course in Engineering as applied especially to Railways, Highways and Municipal Works.

Course III. contemplates especially processes in Mining and Metallurgy subsequent to the delivery of the ore above ground. It fits a man for a position as Chemist and Assayer or in other connection with concentrating plants and smelters.

Two options are offered in the Senior year as the candidate may wish to specialize in the direction of Metallurgy or of Analytic Chemistry.

For the completion of any of these courses the degree of Bachelor of Science is given. The further degree of Engineer of Mines, Civil Engineer or Metallurgical Engineer will either be conferred for an additional year's post-graduate work, approved in quantity and character by the Faculty; or may be awarded to graduates who have had practical experience in the work of their profession of such duration and value as to warrant its bestowal.

Following is a table giving the distribution of the work required in the courses, with the number of exercises per week in each subject and the hours of the day at which these occur. Readers who seek information as to the content of any course should study it as outlined in the table, turning to the subsequent departmental statements for description of the instruction given in the various subjects.

FRESHMAN YEAR.

FIRST TERM.

Hours for Lectures.	Course in Mining Engineering.	No. per week.	Course in Civil Engineering.	No. per week.	Course in Chemistry and Metallurgy.	No. per week.
8:30- 9:30...	English Course II. ...	3	English Course II ...	3	English Course II ..	3
8:30- 9:30...	Elementary Physics	2	Elementary Physics..	2	Elementary Physics .	2
9:30-10:30...	Plane Geometry	4	Plane Geometry.....	4	Plane Geometry.....	4
9:30-10:30...	Elementary Physics. .	1	Elementary. Physics..	1	Elementary Physics .	1
10:30-12:30...	Drawing (Section I).	3	Drawing (Sec. I)	3	Drawing (Sec. I).....	3
10:30-12:30...	Shop Practice (Sec. I)	2	Shop Practice (Sec. I)	2	Shop Practice (Sec. I)	2
2:00- 3:00...	Higher Algebra	5	Higher Algebra.....	5	Higher Algebra.....	5
3:00- 5:00...	Drawing (Section II)..	3	Drawing (Sec. II).....	3	Drawing (Sec. II).....	3
3:00- 5:00...	Shop Practice (Sec. II)	2	Shop Practice (Sec. II)	2	Shop Practice (Sec. II)	2

SECOND TERM.

8:30- 9:30...	English Course II.....	3	English Course II.....	3	English Course II.....	3
8:30- 9:30...	Element'ry Mechanics	2	Element'ry Mechanics	2	Element'ry Mechanics	2
9:30-10:30...	Solid Geometry.....	4	Solid Geometry.....	4	Solid Geometry.....	4
10:30-11:30...	Element'ry Chemistry	3	Element'ry Chemistry	3	Element'ry Chemistry	3
10:30-12:30...	Drawing (Sec. I).....	1	Drawing (Sec. I).....	1	Drawing (Sec. I).....	1
10:30-12:30...	Shop Practice (Sec. I)	2	Shop Practice (Sec. I)	2	Shop Practice (Sec. II)	2
2:00- 3:00...	Plane Trigonometry..	5	Plane Trigonometry..	5	Plane Trigonometry..	5
2:00- 3:00...	Drawing (Sec. II).....	1	Drawing (Sec. II). ...	1	Drawing (Sec. II).....	1
3:00- 5:00...	Chemical Laboratory.	1	Chemical Laboratory.	1	Chemical Laboratory.	1
3:00- 5:00...	Shop Practice (Sec. II)	2	Shop Practice (Sec. II)	2	Shop Practice (Sec. II)	2

SOPHOMORE YEAR.

FIRST TERM.

Hours. for Lectures.	Course in Mining Engineering.	No. per week.	Course in Civil Engineering.	No. per week.	Course in Chemistry. and Metallurgy.	No. per week.
8:30- 9:30...	Descriptive Geometry	2	Descriptive Geometry	2	Descriptive Geometry	2
8:30- 9:30 ..	Surveying.....	1	Surveying.....	1	.....	..
9:30-10:30...	Analytic Geometry....	5	Analytic Geometry....	5	Analytic Geometry....	5
10:30-11:30...	French or German....	3	French or German	3	German.....	3
11:30-12:30...	General Inorganic Chemistry..... ...	3	General Inorganic Chemistry.....	3	General Inorganic Chemistry.....	3
2:00- 5:00...	Drawing and Field Practice.....	3	Drawing and Field Practice.....	3	Drawing.....	2
1:30- 5:30 ..	Chemical Laboratory.	2	Chemical Laboratory.	2	Chemical Laboratory.	3

SECOND TERM.

8:30- 9:30...	Surveying.....	2	Surveying.....	2	....	..
8:30- 9:30...	Physics.....	3	Physics.....	3	Physics.....	3
9:30-10:30...	Differential Calculus..	3	Differential Calculus	3	Differential Calculus.	3
10:30-11:30...	French or German....	3	French or German....	3	German.....	3
11:30-12:30...	Applied Chemistry....	3	Applied Chemistry...	3	Applied Chemistry...	3
2:00- 5:00...	Drawing and Field Practice.....	1	Drawing and Field Practice.....	3	Drawing	1
1:30- 5:30...	Chemical Laboratory.	4	Chemical Laboratory.	2	Chemical Laboratory.	4

JUNIOR YEAR.

FIRST TERM.

Hours for Lectures.	Course in Mining Engineering.	No. per week.	Course in Civil Engineering.	No. per week.	Course in Chemistry and Metallurgy.	No. per week.
8:30- 9:30...	Integral Calculus.....	3	Integral Calculus.....	3	Integral Calculus.....	3
8:30- 9:30...	*French.....	2	*French.....	2	Theoretic'l Chemistry	3
9:30-10:30...	Ore Dressing..	1	Lines of Com'unicat'n	2	....	..
10:30-11:30...	Physics.....	3	Physics.....	3	Physics.....	3
10:30-11:30...	Mineralogy.	2	Mineralogy.....	2	Mineralogy.....	2
11:30-12:30...	Ore Dressing	2	....	..	Ore Dressing.....	2
11:30-12:30. .	*German.....	3	*German....	3	German.....	3
2:00- 5:00...	....	..	Drawing and Field Practice.....	3	....	..
2:00- 5:00...	Physical Laboratory..	2	Physical Laboratory..	2	Physical Laboratory..	2
1:30- 5:30...	Chemical Laboratory.	3	....	..	Chemical Laboratory.	3
Mondays....	Practic'l Ore Dressing	..	....	..	Practic'l Ore Dressing	..

SECOND TERM.

8:30- 9:30...	Analytic Mechanics..	3	Analytic Mechanics..	3	....	..
8:30- 9:30...	French or German...	2	French or German....	2	German.....	2
9:30-10:30...	Materials of Engin'g Masonry Constr'ct'n	.. 2	Materials of Engin'g Masonry Constr'ct'n	.. 2	Materials of Engin'g Masonry Constr'ct'n Theoretic'l Chemistry	.. 2 3
9:30-10:30...	Mining.....	2	....	..	....	..
10:30-11:30 ..	Stereotomy.....	1	Stereotomy	1	Stereotomy.....	1
10:30-12:30...	Mineralogy.....	2	....	..	Mineralogy.....	2
11:30-12:30...	Metallurgy.....	3	Metallurgy...	3	Metallurgy.....	3
2:00- 5:00...	Drawing and Field Practice.	2	Drawing and Field Practice.....	3	....	..
2:00- 5:00	Physical Laboratory..	1	Physical Laboratory..	2	Physical Laboratory..	2
1:30- 5:30...	Chemical Laboratory.	2	....	..	Chemical Laboratory.	3
Mondays....	Practic'l Ore Dressing	..	....	..	Practic'l Ore Dressing	..

* Alternative.

SENIOR YEAR.

FIRST TERM.

Hours for Lectures.	Course in Mining Engineering.	No. per week.	Course in Civil Engineering.	No. per week.	Course in Chemistry and Metallurgy.	No. per week.
8:30- 9:30...	Geology.....	3	Geology.....	3	Geology.....	3
8:30- 9:30 ..	Metallurgy....	2	.....	..	Metallurgy.....	2
9:30-10:30...	Metallurgy.....	1	Astronomy	2	Metallurgy..	1
9:30-10:30...	.....	..	.....	.	Metallurgical Problems.....	1
10:30-11:30...	Hydraulics and Graphic Statics..	5	Hydraulics and Graphic Statics..	5	Electro-Metallurgy...	2
11:30-12:30...	Electrical Transmission.....	2	Electrical Transmission.....	2	Electrical Transmission.....	2
11:30-12:30...	Mining	3	.....	.	.....	..
2:00- 5:00...	Mining Design	3	.....	..	Metallurgical Design.	2
2:00- 5:00 ..	Metallurgical Laboratory.....	1	Drawing and Field Practice...	3	Metallurgical Laboratory.....	1
.....	.....	..	....	.	Chemical Laboratory.	..

SECOND TERM.

8:30- 9:30...	Economic Geology...	3	Economic Geology....	3	Economic Geology....	3
8:30- 9:30...	....	..	.....	.	Metallurgical Problems..	1
9:30-10:30...	Metallurgy.....	3	....	..	Metallurgy.....	3
9:30-10:30. .	Electrical Transmission.....	2	Electrical Transmission.	2	Electrical Transmission.....	2
10:30-11:30...	.....	..	Bridge and Sanitary Engineering	5	....	..
11:30-12:30 ..	Prime Movers and Power Transmis'n	3	....	.	....	..
11:30-12:30...	Mechanics of Engineering..	2	Mechanics of Engineering.....	2	.....	.
2:00- 5:00...	Physical Laboratory..	2	Physical Laboratory..	2	Physical Laboratory..	2
2:00- 5:00...	.....	..	Drawing and Designing.....	3	Metallurgical Design.	1
2:00- 5:00..	Mining Design	1	.....	..	....	..
Mondays....	Metallurgical Laboratory.....	..	....	..	Metallurgical Laboratory.....	..
	Thesis.....	..	Thesis.....	..	Chemical Laboratory and Thesis..	..

The table shows the Metallurgical option in the Senior Year of Course III. Those who wish to specialize in the direction of Analytic Chemistry will in that year take Geology (3) and Metallurgy (3) throughout the year; Electro-Metallurgy (2) and Physical Laboratory (2) in the first term, devoting all the remainder of their time to work in the Chemical Laboratory.

Special Courses.

For the benefit of those who may lack the time, the money or the inclination to spend four years in preparation for professional work, certain special courses, designed to confer competent knowledge of particular departments of engineering work are offered. These are :—

I. ASSAYING AND TECHNICAL ANALYSIS.

This course, which is outlined on pages 31–33, may, with diligence, be completed by mature students who have some knowledge of Chemistry, in one year. An additional year, which may in some cases be necessary, may in all cases be profitably spent in more work in Analytical Chemistry and related electives.

II. SURVEYING.

The purpose of this course is to turn out competent Land and Mine Surveyors and fair draughtsmen. The essentials of it are a thorough knowledge of Algebra, Geometry, Trigonometry, Surveying, Descriptive Geometry and Stereotomy, with Field Practice and Drawing. It may be completed in one year or in two years, according to the advancement of the applicant upon entrance. By combining with this the courses in Mineralogy, Geology, Mining and Ore-dressing, industrious students, especially such as have had some practical experience, may in two years attain considerable competency for the conduct of mining operations.

III. ELECTRICITY.

A knowledge of the theory of Electricity and some acquaintance with its manifold applications in the arts is in these days of prime importance to every engineer — especially to the mining engineer, whose duties are so varied. Hence, in the regular courses this subject receives a liberal share of attention. The School does not design to offer a course in electrical engineering, but students who have completed satisfactorily the courses in Shop Work, in Chemistry through the Sophomore year, in Mathematics through the Calculus, and in General Physics, with all the undergraduate work, both theoretical and practical, in Electricity and Magnetism as outlined on pages 45–47, will have attained a considerable proficiency in Electricity, theoretical and applied.

Applicants will be admitted to these courses only when they are of such maturity, have had such preparation, and evince such seriousness of intention as to indicate that they are likely to pursue the same with profit. Matriculates in any of the regular degree courses will not be allowed to lapse into a special course except upon presentation to the Faculty of convincing reasons for such change.

For the satisfactory completion of any of the special courses a Certificate of Proficiency in the course pursued is granted.

Engineering.

Prof. Harris.

G. E. Miller, Instructor in Shop Work and Drawing.

FRESHMAN YEAR.

Shop Work.— All Freshmen spend four hours per week in the shop. This work is intended to familiarize the student with the practice and theory of wood-working as employed in engineering construction. The course consists of a series of graded exercises on the bench and lathe which involve the principles of joining, pattern making and construction. These are followed by the making of parts of engineering structures, or of complete small structures, from detail drawings prepared by the upper class-men in their engineering designs, or by the instructor.

Students are required to make a working drawing of each exercise before its execution in the shop.

Drawing.— Freshmen devote four hours per week to this work, which consists of exercises in ruling, line-shading, etc., calculated to teach the use of drawing instruments, followed by a thorough drill in free-hand lettering, pencil sketching and drawing from models, scaled machine and architectual drawings from detail plates, tracing and blue-printing.

SOPHOMORE YEAR.

FIRST TERM.

DESCRIPTIVE GEOMETRY.—Theory of parallel and of central projections as applied to science of drawing, with numerous exercises in determining projections of familiar objects; intersections of plane and of curved surfaces; sections, developments and shadows; perspectives. Text — Low's Descriptive Geometry. (Twice a week.)

FIELD INSTRUMENTS.— The field instruments of the engineer are dissected and studied in every detail, their theory, construction and adjustments receiving careful attention. Their uses and capabilities are thoroughly discussed and applied in field practice. Lectures. (Once a week.)

DRAWING.— Brush shading in India ink, of plain, cylindrical, spherical, and other surfaces. Much time is given to exercises in descriptive geometry, and to preparing plats of surveys made in field practice. (Drawing or Field Practice three times a week.)

FIELD PRACTICE.— The student is first taught to adjust the instruments properly and to test their accuracy. Problems are then assigned in traversing and parting off land, in direct and indirect leveling, and in triangulations, all of which must be carried out in the field. (Drawing or Field Practice three times a week.)

SECOND TERM.

ENGINEERING GEODESY.— General and particular methods of traversing, triangulating, direct and indirect leveling; land, city, topographical, hydrographical and mine surveying; United States system of subdivisions of land. Text — Johnson's Surveying, with lectures. (Twice a week.)

DRAWING.— Some complete engineering structure must be presented in isometric, another in perspective. A neat topographical map must be made from notes taken in field practice.

FIELD PRACTICE.— The exercises in Field Practice are continued. Topographical Surveying will receive particular attention. (Drawing or Field Practice, three times a week.)

JUNIOR YEAR.

FIRST TERM.

RAILWAY ENGINEERING (*Civil Engineering Course*).— Surveys, construction and maintenance of railways. Text — Searles' Field Book, with lectures. (Twice a week for 14 weeks.)

STREET AND HIGHWAY ENGINEERING (*Civil Engineering Course*).— Surveys, construction and maintenance. Text — Byrnes' Highway Construction, with lectures. (Twice a week for 4 weeks.)

DRAWING.— The work assigned in drawing is adapted to the profession chosen by the student. It will consist of plats, profile and sections from notes taken in field practice, and of working drawings of simple engineering structures. Such drawings must be accompanied by estimates of material and of cost.

FIELD PRACTICE.— The student is exercised in Railway Surveying and in setting out earthwork and masonry. A map, profile and estimate of cost of a section of a railway must be produced from notes taken in field practice. (Drawing or Field Practice, three times a week.)

MASONRY CONSTRUCTION.— Foundations, strength and stability of stone and brick masonry, concretes, cements and

mortars. Specifications. Text — Baker's Masonry Construction. (Twice a week.)

STEREOTOMY.—The application of Descriptive Geometry to the art of stone-cutting — obtaining the projections, templets and directing instruments for the individual stones in the various forms of structures, and the construction of models of the same. Text — Warren's Stone-Cutting, with lectures. (Once a week.)

FIELD PRACTICE AND DRAWING.— Work of first term continued. The standard method of testing cement will be carried out in detail. (Three times a week.)

SENIOR YEAR.

FIRST TERM.

HYDRAULICS.— Collection and measurement of water; conveyance through pipes and canals; design of pipe lines. Text — Merriman's Hydraulics. (Five times a week for 12 weeks.)

STATICS OF ENGINEERING STRUCTURES.— General study of static forces — graphically and analytically — with applications in determining conditions of stability of engineering structures and strains in simple framed structures; design of beams and posts. (Five times a week for 8 weeks.)

FIELD PRACTICE AND DRAWING.—Senior classmen must direct and check the work of the Sophomore and Junior classes. A variety of exercises in graphic statics will be assigned. (Three times a week.)

SECOND TERM.

BRIDGE ENGINEERING (*Civil Engineering*). — Loads on bridges and roofs, strains in pieces — design and dimensions

of pieces; design of connections. Text — Johnson's Structures and Dubois' Strains in Framed Structures. (Five times a week for 12 weeks.)

PRIME MOVERS (*Mining Engineering*). — Hydraulic motors, steam engines and boilers. (Twice a week for 12 weeks.)

SEWERAGE, WATER SUPPLY OF CITIES AND IRRIGATION (*Civil Engineering*). — (Five times a week for 8 weeks.)

ASTRONOMY.— Determination of latitude, longitude and time, with reading and lectures in Descriptive Astronomy. (*Civil Engineering.*) Twice a week for 8 weeks.)

DRAWING AND DESIGNING.— Detail working drawings of some of the structures studied will be required. The thesis must be accompanied by illustrative drawings. (Three times a week.)

LABORATORY WORK (*Mining Engineering*). — Experiments with the indicator, calorimeter and dynamometer.

Chemistry.

Prof. Allen. Mr. Larsh.

The courses in this department are intended for technical students, and while the application of chemical principles is made in a practical way throughout the work, all the instruction aims to eliminate the "rule of thumb," and lays stress on the importance of principle.

The following courses are offered and regularly given: —

1. General Chemistry.— Three hours of class-room work for one year, and one afternoon of laboratory work for one-half year.

(a.) First half. (Freshman Year — 2d Term.) Fundamental Principles and Chemistry of the acid-forming elements.

(b.) Second half. (Sophomore Year — 1st Term.) Descriptive Chemistry of the most important metals.

The instruction is given by lectures fully illustrated by experiments, and by laboratory work. Text-book — Remsen's Briefer Course in Chemistry.

2. Qualitative Analysis (Sophomore Year).—Three afternoons per week in General Courses I. and III. In Course II., three afternoons per week during the first term and two in the second. A few introductory lectures are given, but most of the instruction is given individually in the laboratory.

3. Quantitative Analysis (Junior and Senior Years).— 1st Year. The equivalent of three afternoons per week throughout the year.

The determinations during the first term are intended more especially to teach exactness, though the problems are all such as one would meet with in practical work, and in every case the student is given practice in the best rapid methods, where such exist, on some mineral or commercial substance.

In the second term, analysis of iron, zinc, copper and lead ores are made. A part of this term is also devoted to the fire-assay of gold, silver and lead ores.

2d year. For Students in Course III.

The work for this year is arranged to meet the wants of the individual student. Opportunities in the way of apparatus and material are afforded to those who expect to follow particular lines of chemical work. The regular work embraces gas analysis, water analysis, analysis of irons, steels, fuels, slags and other commercial products. Reference Books — Fresenius, Sutton, Hempel, Crooks, Classen, Brown, Blair, A. H. Allen, etc., besides the Zeitschrift für analytische Chemie and other journals are at the use of the student.

4. Applied Chemistry (Sophomore Year — Second Term).— Three hours per week. A course of lectures treating the chemical principles involved in the following subjects : —

(a.) Sanitary Chemistry.

The Atmosphere, Air Analysis, Disinfectants, Natural Waters, Water Analysis, Water Supplies, Sewage and Sewage Disposal.

(b.) Industrial Chemistry.

Fuels, Illuminants, Refractory Materials, Building Materials, Wood Preservatives Explosives, etc. The subjects most fully treated are those which Mining and Civil Engineers are most likely to need in their practice. Students are encouraged to visit industrial plants.

5. Theoretical Chemistry (Junior Year).— Three hours per week. The lectures deal with the development of chemical theory, chiefly from the historical point of view, as follows :—

Beginnings of Quantitative Work, Laws of Chemical Combination, Atomic Theory, Molecular and Atomic

Weights, Interrelations of the Atoms. Constitution of the Molecule, Stereo-Chemistry. Chemical Reactions, Equilibrium of Chemical Systems, Reaction, Velocity, Thermochemistry.

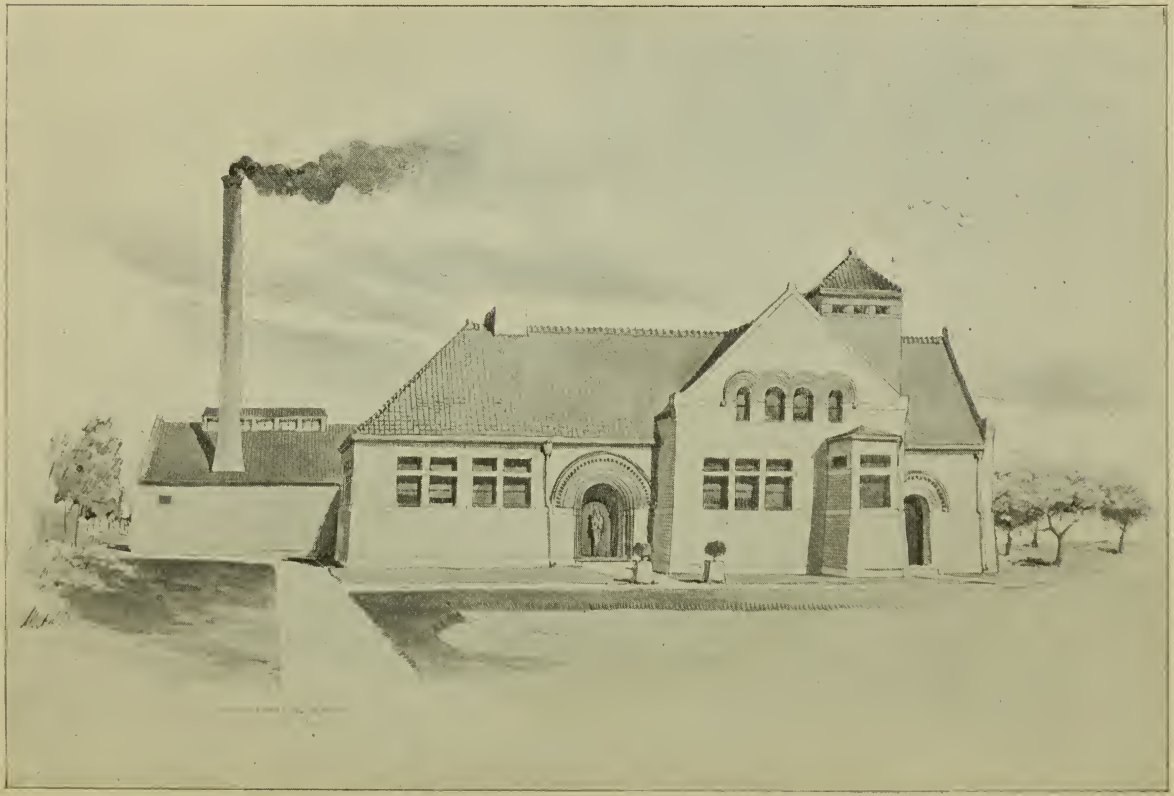
The sources are the recognized authorities in each department of the subject — Kopp, Hoefer, Wurtz, von Meyer, Lothar Meyer, Muir, Ostwald, Nernst, Mendeleeff, etc. No text-book was used in 1895–6.

6. Technical Analysis and Assaying (Special Course).— One year, four afternoons per week. This embraces especially fire assaying for gold, silver and lead ores, and commercial methods for iron, lead, zinc and copper in the wet way, as well as complete analysis of the more common ores so far as time permits.

An Assayer's certificate is given to candidates who satisfactorily complete Courses 1, 2, 4 and 6.

ELECTIVE.

Organic Chemistry.— A course of lectures three hours per week for one-half year is open to students pursuing the Course in Chemistry and Metallurgy and such others as have completed Courses 1 and 2. This course will not be given unless elected by at least four students.



Mining and Metallurgical Laboratory.

Mining and Metallurgy.

Prof. DeKalb.

The work in this department is designed primarily with a view to the needs of students who have elected the specialties of Mine Engineering and Metallurgy. Stress is consequently laid upon practical methods throughout.

In the brief period of a course of collegiate education it is not possible to train a student to that skill in engineering and metallurgical operations which comes only from long experience in the field, but the best procedure, in accordance with modern practice, is taught in lecture room and laboratory, along with careful training in the application of fundamental principles, thus enabling the industrious to acquire proficiency in standard methods of Mining and Metallurgy, and to be able to deal independently with new or difficult problems which may present themselves in practice. Projets, memoirs, reports on visits of inspection to mines, metallurgical works, etc., with geological field work, are given due importance in the courses. An important feature of the instruction in this department consists in original experimental investigation in the practical concentration and metallurgical treatment of various ores in the Ore Dressing and Metallurgical Laboratory, which contains a large plant of the most approved types of machines and other appliances for such purposes. In this portion of the course the student is required, as far as possible, to exercise independence of judgment, and to rely upon his own resources.

SYNOPSIS OF COURSES.

COURSE IN MINERALOGY AND GEOLOGY.

MINERALOGY. — Mathematical crystallography is taught as an introduction to the course, followed by determinative mineralogy. The most important metalliferous and rock-forming minerals are carefully studied, so that the student may become familiar with those of chief economic value, and with such as will concern him in ore-dressing and metallurgical practice. Moses' Mineralogy and Blow-pipe Analysis is used as a text. (Junior. First term, two hours per week; second term, four hours per week.)

LITHOLOGY.— The practical determination of rocks is treated as a continuation of mineralogy, Williams' Lithology being used as a basis. (Junior. Second term, part of time allotted to Mineralogy.)

DYNAMICAL GEOLOGY.— Le Conte's Elements of Geology is employed as a text, supplemented by lectures. The work is continued into the making of Geological Maps and sections. (Senior. First term, three hours per week, for half term.)

HISTORICAL GEOLOGY.— The same text as above is used, supplemented by practice in the determination of fossils with reference to the identification of geological horizons. (Senior. First term, three hours per week, for half term.)

ECONOMICAL GEOLOGY.— This is a series of lectures and recitations, dealing with the occurrence, distribution, and uses of ores, clays, stones, and other products of economical value from the different geological formations, including a

thorough treatment of the characteristics and genesis of ore deposits. (Senior. Second term, three hours per week.)

COURSE IN MINING.

MINING.— Lectures on Prospecting, Drilling and Well-boring, Exploitation, Method of Extraction, Blasting, Transportation, Drainage, Ventilation, Lighting, Accidents, Hygiene, Mining Law, Sampling and Examination of Mines, and Quarrying extend through two terms. Practical problems, projets, and reports on visits of inspection, constitute features of the course. (Junior. Second term, two hours per week. Senior. First term, three hours per week.)

MINE SURVEYING.— Some additional matter, such as methods adapted to special cases, with problems involving the principal conditions encountered in mine surveying, are included in the course in Mining. The subject of mine surveying constitutes part of the course in Engineering Geodesy in the Department of Engineering. (Senior. Part of Mining.)

ORE DRESSING.— A course of lectures, with practical problems, projets, etc., on the principles, methods and leading mechanical appliances in use to-day, for crushing, comminution, classification and concentration of all important ores, together with a thorough treatment of the preparation of coal, magnetic separation and the magnetization, enrichment, and elimination of impurities from hematite iron ores. (Junior. First term, three hours per week.)

MINING DESIGN.— Involves the designing, making out of specifications, and execution of working drawings of hoisting works, mine drainage and ventilation plants, transportation systems, laying out of mines, etc. May constitute

a part of Thesis work. (Senior. First term, three afternoons per week; second term, one afternoon per week.)

ORE DRESSING LABORATORY.— Mondays throughout the Academic year are accredited to work in practical tests in the crushing, classification and concentration of ores. This time, however, is materially shortened by the discontinuance of these tests during a portion of the mid-winter months. The object is to give the student experience in the more common methods of ore dressing treated in the lectures on this subject, and to afford him practice in the application of theory to the production of useful results. The laboratory is fitted with crushers, rolls, a stamp battery, hydraulic classifiers, jig, frue-vanner, etc. Detailed reports are required on all work done. (Junior. Part of first and second terms, Mondays.)

COURSE IN METALLURGY.

GENERAL METALLURGY.— A course of lectures and recitations, using Roberts-Austen's "Introduction to the Study of Metallurgy" as a basis. A thorough drilling is given in the application of chemistry, including thermo-chemistry, to metallurgy; fuels, natural and artificial, their application and efficiency; gas producers; utilization of by-products; furnaces, types and construction; chimneys; metallurgical processes; refractory materials; fluxes; slags, their characteristics and calculation; alloys, etc. Practice problems are assigned for solution throughout the course. (Junior. Second term, three hours per week for half term.)

METALLURGY OF IRON AND STEEL, COPPER, LEAD, SILVER, GOLD, ZINC, NICKEL, ETC.—A course of lectures covering the methods of extraction of metals from their ores, in con-

formity with the best modern practice. Parallel reading in standard treatises, such as Peters on Copper Smelting, Hofman on Lead Smelting, etc., is required, supplemented by laboratory practice. (Junior. Second term, three hours per week, for half term. Senior. First and second terms, three hours per week.)

METALLURGICAL PROBLEMS. — This course is intended for further specialization on the side of metallurgy for students taking the course in Chemistry and Metallurgy. It involves problems in advanced metallurgy, heat distribution, calculation of charges, special treatment of unusual or difficult ores, testing for process, designs of metallurgical plants, etc. (Senior. First and second terms, one hour per week.)

METALLURGICAL DESIGN.—The design and laying out of works, design of furnaces, with appropriate accessory machinery, etc., is taught in the draughting room. All work is original and is done from specifications. This may constitute a part of thesis work. (Senior. First term, two afternoons per week; second term, one afternoon per week.)

METALLURGICAL LABORATORY.— Mondays throughout the academic year are given to practice in the treatment of metals, following parallel lines with the instruction by lectures. Experience is obtained in pyrometry, and determination of the calorific power of fuels; in tests of refractory materials; formation and characteristics of slags; testing for process; roasting of ores; smelting of lead, zinc and copper ores; milling of gold and silver ores; wet methods for extraction of copper, gold, and silver; electrometallurgy, etc. The laboratory is well equipped with a water jacket blast furnace, roasting and other furnaces, and

appliances for wet methods of treatment. Detailed reports are required upon all investigations and tests made. (Senior First and second terms, Mondays.)

SUMMARY.

JUNIOR YEAR.

Mineralogy.
Lithology.
Mining.
Mine Surveying.
Ore Dressing.
Practical Ore Dressing.
Principles of Metallurgy.
Metallurgy of Iron and Steel.

SENIOR YEAR.

Mining.
Mining Design.
Dynamical Geology.
Historical Geology.
Economic Geology.
Ore Deposits.
Metallurgy of Copper, Lead, Zinc, etc.
Metallurgical Problems.
Metallurgical Design.
Metallurgical Laboratory.

Mathematics.

Prof. Richards.

The exceeding importance of Mathematics as the basis of a scientific education justifies the emphasis laid upon it in the school. At the same time that the facts are taught, the utility of mathematical study as a mental discipline is duly recognized, and an effort is made to promote habits of exact,

logical reasoning, and to stimulate originality and independence of thought.

In the various courses the ultimate intention of the student is kept prominently in mind, and such points as have an especial bearing upon his technical work are emphasized as occasion may suggest. The tendency, however, too frequently observable in technical schools to cramp the mathematical instruction within the limits of a meager preparation for professional work, is avoided, and the treatment of each subject is, in general, designed to be as broad and full as may be in the allotted time.

At each meeting the class is examined on matter previously assigned, and, when expedient, explanations of the text and supplementary lectures and notes are given. The student is constantly exercised in work at the blackboard, reproducing demonstrations and applying demonstrated principles to the solution of special problems.

FRESHMAN CLASS.

GEOMETRY.—The class meets four times a week throughout the year, and completes the usual course in Elementary Geometry, Plane and Solid, with numerous original exercises.

Text-book.— Wells' Plane and Solid Geometry.

HIGHER ALGEBRA.— At the outset the class will review Radicals and Quadratic Equations. Thereafter the course will include Theory of Exponents, Surds, Imaginaries, the Progressions, Permutations and Combinations, Binomial, Theorem, Series of Logarithms, Theory of Numbers, Determinants, with an introduction to the Theory of Equations. (Five times a week for five months.)

Text-book.— Wells' University Algebra, with notes.

PLANE TRIGONOMETRY.— The class is thoroughly drilled in the Fundamental Definitions and Formulae, and exercised in the manipulation of trigonometric equations. The construction and use of Logarithmic tables are taught, and numerous examples in the solution of triangles, involving the use of Logarithms, are given. Occasionally actual heights and distances are required to be calculated by trigonometric methods. (Five times a week for four months.)

Text-book.— Wells' Trigonometry.

SOPHOMORE YEAR.

FIRST TERM.

SPHERICAL TRIGONOMETRY.— A brief course, with some illustrations of its applications in Geodesy and Astronomy. (Five times a week for one month.)

Text-book.— Wells.

ANALYTIC GEOMETRY (PLANE).— The remainder of the first term is spent in the study of the Conic Section and some of the most important and interesting curves of higher degree.

Text-book.— Wentworth's Analytic Geometry.

For Reference.— Puckle's Conic Sections, Salmon's Conic Sections and Higher Plane Curves.

SECOND TERM.

ANALYTIC GEOMETRY (Solid).— The instruction includes an elementary discussion of the Line, the Plane, and surfaces of the second degree. Wentworth's Analytic Geometry is continued as a text-book, but the treatment on the subject there given is supplemented by notes. (Three times a week for four weeks.)

DIFFERENTIAL CALCULUS.— During the remainder of the

term the class meets three times a week, and studies the Differential Calculus.

The student is guarded against the error of supposing that the Calculus means any certain body of knowledge, small or large, and is taught to view it in its true light as a method of analysis, the applications of which are infinite. The logical foundation of the subject is firmly laid in the Doctrine of Limits, and the class is introduced to the applications — both geometrical and mechanical — of its principles, which are most important, both on account of the intrinsic utility of their results, and, as well, as illustrating the efficiency of the instrument which the student is learning to use.

Text-book.— Osborne's Calculus, with lectures.

For Reference.— Williamson, Todhunter.

JUNIOR YEAR.

FIRST TERM.

DIFFERENTIAL AND INTEGRAL CALCULUS AND APPLICATIONS.— The course of the last term is continued. Among the subjects to which the Calculus is applied are the investigation of maxima and minima values of functions, the analytical study of curves, and the finding of lengths, areas and volumes by definite integration. (Three times a week.)

Text-book.— Osborne's Calculus, with lectures.

For Reference.— Williamson, Todhunter, etc.

SECOND TERM.

ANALYTIC MECHANICS.— The fruit of the training in Pure Mathematics is here tasted. The principles of Statics are developed and applied to various problems. Among the topics treated are Center of Mass, Friction, the Machines Funicular Polygon, Catenary and Spherical Attraction, etc.

In Kinetics, the fundamental equations of Motion, Projectiles, Work and Energy, Moment of Inertia are especially considered. (Three times a week.)

Text-book.— Bowser's Analytic Mechanics.

GRADUATE STUDENTS.

Graduate students who elect work in this department will be permitted to exercise considerable latitude of choice, within the approval of the Professor. They may make a wider study of the Conic Sections by both Algebraic and Projective methods (Salmon, Cremona), Advanced Calculus (Williamson), Theory of Equations (Burnside and Panton), Determinants (Muir or Weld). Or, if they desire to pursue subjects more directly related to the physical sciences, they may take Dynamics (Williamson), Quaternions (Kelland and Tait), Differential Equations (Johnson).

In all the classes, as each subject is taken up its origin and development are studied too, and at certain periods, more formal lectures on the History of Mathematics are given.

A collection of the chief works on Mathematics, in English, French and German, which is contained in the Library, affords the student an opportunity of extending his research at will.

Physics.

Prof. Timmerman.

COURSE 1. ELEMENTARY PHYSICS. — The Freshman class meets three times a week during the first term for the study of Elementary Physics. The course is designed as an

introduction to the work of the Sophomore and Junior years. The fundamental principles of physics are discussed as fully as the time allotted will permit. The work is carried on by lecture and recitation; the lectures being well illustrated by simple experiments.

Text-book. — Elements of Physics by Carhart and Chute.

COURSE 2. ELEMENTARY MECHANICS. — During the second term of the Freshman year the subject of Elementary Mechanics is taught twice a week. The subjects treated include the fundamental principles of Kinematics, Statics and Kinetics. The work is designed to give the student a knowledge of force, mass, velocity, acceleration, work, energy, etc. Particular attention is paid to the magnitude of the units in which the various quantities introduced are measured.

Text-book. — Elementary Mechanics, by Magnus.

COURSE 3. ELECTRICITY AND MAGNETISM. — Lectures and recitations three hours a week during the first term. This course is designed as an introduction to the study of Electricity and Magnetism. Open to all who have completed 1 and 2.

Text-book. — Lessons in Electricity and Magnetism, by S. P. Thompson.

COURSE 4. PRACTICAL ELECTRICITY. — Lectures and recitations three hours a week during the second term. The work during this term deals with the principles underlying the construction of dynamos and motors. Open to all who have completed 1, 2, and 3.

Text-book. — Slingo and Brooker's Electrical Engineering.

COURSE 5. LABORATORY WORK IN ELECTRICITY AND MAGNETISM. — Two afternoons a week throughout the year.

COURSE 6. GENERAL PHYSICS.— The study of advanced physics is taken up during the second term of the Sopho-

more year and continued during the first term of the Junior. The work consists of lectures and recitations three hours a week. The Sophomores review the elementary principles, and then enter upon the more careful study of the principles of kinematics, statics and kinetics. Particular attention is paid to the subject of harmonic motion as the basis for the study of the subjects of Sound and Light, to which the time is devoted during the remainder of the term.

The method of the calculus is employed without its formal symbols.

During the first term of the Junior the students devote three hours a week to the study of Heat, Electricity and Magnetism. The calculus is freely employed, where necessary, to derive fundamental principles. The study of the subject of Heat includes an introduction to the study of Thermo-dynamics. In the work on Magnetism and Electricity particular attention is paid to the magnitude of the electro-static and of the electro-magnetic units, as a necessary aid to the comprehension of such terms as potential, current, capacity, etc.

The lectures throughout are illustrated by experiments. At the end of the course several lectures on the Electro-Magnetic Theory of Light are given.

Text-book.— Carhart's University Physics.

Course 7. Laboratory Work in Mechanics, Sound and Light.— In the laboratory the work is quantitative and aims as far as possible to instruct the student in the methods of physical measurements and the derivation of relations among the quantities measured; in other words at the derivation of simple laws rather than the verification of them. Required of Juniors two afternoons during the first term.

Course 8. Laboratory Work in Heat, Electricity and Magnetism.— The work in the laboratory is continued

by the Juniors during the second term, students in Civil Engineering taking laboratory twice a week, while those in Mining Engineering and those in Chemistry and Metallurgy take laboratory but once a week.

COURSE 9. ELECTRICAL TRANSMISSION OF ENERGY.—The Seniors meet twice a week throughout the year for the study of Electrical Transmission. During the first term the generating plant, including engine and boilers, is discussed. The second term is employed in the discussion of the principles underlying the economical transmission of electrical energy and its transformation. The work is carried on by lecture and recitation. Open to students who have completed the course in General Physics and the Mathematics through the calculus.

10. DYNAMO LABORATORY.— The work in the Dynamo Laboratory includes the testing of dynamos, motors and transformers, the calibration of instruments and characteristic curves of dynamos, motors, etc. In connection with the work engine and boiler tests are also made. Required of Seniors two afternoons a week during the second term. Open to those who have completed one term of Course 9.

11. ELECTRO-METALLURGY.— Two hours a week during the first term. The course includes a general discussion of electrolysis and its application in chemistry and electro-metallurgy. The principal methods employed to-day are discussed in detail. Required of Seniors in the course in Chemistry and Metallurgy.

Laboratory Text-books.— Stewart & Gee, Vol. I., Elementary Practical Physics, and Vol. II., Electricity and Magnetism; E. L. Nichols, Laboratory Manual, Vol. I. and Vol. II.; Kohlrausch, Physical Measurements.

GRADUATE COURSE.

COURSE 12. THEORY OF ELECTRICITY AND MAGNETISM.— A mathematical treatment of the subject. Two hours a

week throughout the year. Open to graduates and advanced undergraduates.

Text-book. — Electricity and Magnetism, by F. E. Nipher.

COURSE 13. THEORY OF ALTERNATING CURRENTS.— An analytical and geometrical treatment of the subject. Two hours a week throughout the year. Open to graduates and advanced undergraduates.

Courses 12 and 13 will be given in alternate years. Course 12 in 1896-97 and 13 in 1897-98.

Modern Languages.

The great quantity and worth of the technical literature in the French and German languages, added to their value as elements of liberal culture, makes at least a reading knowledge of them a highly desirable part of an Engineer's education. German is required in Course III, while the choice of French or German is permitted in Course I and II.

The instruction in each language is designed to present the grammatical structure and the pronunciation of the tongue, to give some acquaintance with the masterpieces of its literature, and to confer such facility in translation as will enable the student to read with ease the language in both its literary and its scientific uses.

GERMAN.

Mr. Wilkins.

First Year.— Introductory lessons on pronunciation and German script, Collar's Shorter Eysenbach, Joynes' Reader,

Andersen's Maerchen. Five times per week during the first term and thrice per week thereafter.

Second Year.— Grammar and Composition, Schiller's "William Tell," Lessing's "Nathan der Weise," Goethe's "Reinecke Fuchs," and selections from other German authors.

During the second term of this year the students in Scientific German read Hodges' Course in Scientific German. They will also be required to do parallel reading in the current scientific magazines and standard scientific works.

FRENCH.

Prof. Richards.

First Year. — Otto's Grammar, Whitney's Reader, "Choix de Contes" (Daudet).

Second Year.— Grammar (continued), original exercises, Racine's "Phedre," "Le Roman d'un Jeune Homme Pauvre" (Feuillet), "L'Abbe Constantin" (Halevy), Herdler's Scientific French Reader, Marie's "Histoire des Sciences."

Parallel reading, outside of that done in class, will be assigned and will constitute part of the work on which the student is examined.

SPANISH.

Prof. DeKalb.

The growing demand for mining engineers and metallurgists in South and Central America, and in Mexico, where a

knowledge of Spanish is almost an essential qualification, has been met by the establishment of a course in this language in the School of Mines. The natural, or conversational method is followed exclusively, with Ramsey's "Modern Spanish" as a reference grammar.

The object is to give the student not a knowledge of literary Spanish, but facility in every-day speech of the people. The instruction includes a brief course in arithmetic, keeping of accounts, geometry, surveying and chemistry, given entirely in Spanish.

Academic Course.

The Academic Course is maintained in compliance with an Act of the Legislature of 1885. It is intended to include that fundamental general culture which should in part precede and in part accompany specifically technical training — to present a liberal discipline valuable in any career. To those contemplating a professional course, here or elsewhere, who have not laid this foundation; to teachers who desire better equipment for their work, and to any others whose wants it may suffice, this course is offered. As will be seen, studies are offered in English, History, Political Economy, Logic, Mathematics, German, French, and the Natural Sciences.

To enter upon this course a knowledge of Arithmetic and English Grammar is required.

For its completion a Diploma of Graduation in the course is conferred.

ACADEMIC COURSE OF STUDY.

FIRST YEAR.

FIRST TERM.			SECOND TERM.		
Hours of Recitation.	Studies.	Times per week.	Hours of Recitation.	Studies.	Times per week.
8:30- 9:30...	Physical Geography.....	3	8:30- 9:30..	Physiology and Hygiene..	3
8:30- 9:30...	English — *Course I* }	2	8:30- 9:30...	General History.....	2
10:30-11:30 ..	English — *Course I* }	3	10:30-11:30...	English — *Course I*.....	5
11:30-12:30...	General History.....	5	11:30-12:30...	General History.....	3
2:00- 3:00...	Elementary Algebra.. ...	5	2:00- 3:00...	Elementary Algebra.....	5

SECOND YEAR.

8:30- 9:30...	English — *Course II*.....	3	8:30- 9:30...	English — *Course II*.....	3
8:30- 9:30...	Elementary Physics }	2	9:30-10:30...	Geometry (Solid)..... ...	4
9:30-10:30...	Elementary Physics }	1			
9:30-10:30...	Geometry (Plane).....	4	10:30-11:30 ..	German or French..	3
10:30-11:30...	German or French.....	3	2:00- 3.00...	Civil Government.	5

THIRD YEAR.

8:30- 9:30. .	*French (2d year)	2	8:30- 9:30...	*French (2d year).	2
9:30-10:30...	English History.....	5	9:30-10:30...	Political Economy.....	5
10:30-11:30...	Elements of Psychology..	2	10:30-11:30...	Elementary Chemistry...	3
11:30-12:20...	*German (2d year).....	3	11:30-12:30 ..	Logic.....	2
2:00- 3:00...	Higher Algebra.....	5	2:00- 3.00...	Plane Trigonometry.....	5
3:00- 4:00...	Zoology	5	3:00- 4:00...	*German (2d year)..... .	3
			3:00- 4:00...	Book-keeping (optional).	2

* Alternative.

ENGLISH.— In English two courses are offered, as follows : —

Course I. The principles of written discourse ; Letter-writing, and Essay. Written exercises are required daily from the belief that painstaking practice under proper supervision is the best, if not the only, means of acquiring facility in the use of good English. (Five times a week throughout the year.)

Text-book.— Hill's Revised Rhetoric.

Course II.— The History of English Literature from its beginning to the present. It is thought that a thorough knowledge of a few of our great writers is better than a slight knowledge of many. Students are, therefore, required to make a special study of the life, character, and masterpieces of Chaucer, Shakespeare, and such other representative authors as the time will admit. Every effort will be made to have the student acquire the ready use of good English, and to that end biographies, essays, reviews, criticisms, etc., will be required weekly. The Library is supplied with all the books of reference necessary to make this course both interesting and instructive. (Three times a week throughout the year.)

Text-book.— Nicoll's Landmarks of English Literature. Other books will be required as the classes progress.

MATHEMATICS.— A thorough knowledge of Elementary Algebra and Geometry is an essential requisite of a general education, as well as for entrance into higher scientific courses. During the first year students take Elementary Algebra, beginning with the fundamental operations and completing Quadratic Equations and the progressions. In the second year they have a thorough course in Elementary Geometry, Plane and Solid, with much practice in problem-

solving. In the third year they have a course in higher Algebra, including the study of Series, Indeterminate Coefficients, Logarithms, Theory of Equations, Determinants, etc., and complete Plane Trigonometry.

Text-books.— Algebra. First year — Wells' Academic Algebra. Second year — Wells' University Algebra, Wells' Plane and Solid Geometry, Wells' Trigonometry.

General History.— It is desirable that the student have as thorough knowledge as possible of Ancient, Mediæval and Modern History. For this reason the course here offered extends throughout the entire year. Special attention will be given to the growth and development of France, Germany and other modern nations of Europe. Students will be required to make constant use of the books of reference on History, found in the library. (Five times a week throughout the year.)

Text-book.— Myers' General History.

English History.— An effort will be made to present clearly and concisely the main facts in the History of England from the Roman Conquest to the present time. The growth of the political liberties of the people, the changes in social condition, and the advance in literature and arts will be shown as clearly as possible. (Five hours a week during first term.)

Text-book.— Montgomery's "Leading Facts of English History."

French or German.— Students completing the Academic course are required to take two years of German or French. For information concerning the courses offered in these subjects see Modern Languages on pages 48 and 49 of this catalogue.

Physics.— In the course, the object constantly held in view is to present simply and plainly the fundamental truths

of Natural Philosophy. The subjects of properties of matter, sound, light, heat, and electricity are introduced upon a scientific basis and are illustrated throughout the course by experiments. The department is supplied with apparatus of all kinds necessary for this purpose. (Three hours a week during first term.)

Text-book.— Elements of Physics by Carhart and Chute

Elementary Inorganic Chemistry.— In this course careful detailed instruction is given in the fundamental principles of Chemistry, with a description of the most important elements and compounds, and the formation and solution of chemical equations. (Three hours a week during second term.)

Physiology.— It is aimed to make the instruction in this branch as thorough and practical as possible, and to lead the student to obey the injunction "Know Thyself." (Three hours a week during second term.)

Text-book.— Martin's Human Body.

Physical Geography.— The comprehensive nature of this study does not admit of its being treated in all its phases in the short time allotted to it.

The course will be principally descriptive, though the presentation of the scientific principles involved will be as thorough and complete as practicable, the design being to make this study serve as an introduction to the other natural sciences taken up later in the course. (Three hours a week during first term.)

Text-book.— Appleton's Physical Geography.

Civil Government.— The text-book now in use (Young's Class Book) gives an analysis of the Constitution of the United States, presents a comparative view of the different State Governments, treats of County and Township organizations, and affords an acquaintance with such prin-

ciples of law as are involved in ordinary business transactions. Special attention will be given to the Government of the State of Missouri. (Five hours a week during second term.)

POLITICAL ECONOMY.— All that is attempted in this subject, is to present in plain and simple form the elementary principles of Political Economy. The main topics are treated, the fundamental principles studied and discussed, but no attempt is made to inculcate any particular economic doctrine. (Five hours a week during second term.)

Text-book.— Laughlin's Elements of Political Economy.

PSYCHOLOGY.— The aim in this study is to place before the student, in as simple and compact form as possible, a few of the leading facts connected with the human mind — its powers, its capabilities, its growth, and some of the ways by which these powers may be strengthened and cultivated. (Twice a week during first term.)

Text-book.— Hewett's Elements of Psychology.

LOGIC.— This study is intended to supplement that of Psychology. In the latter we have the analysis of the intellectual powers, in the former an investigation of the laws of correct reasoning. (Twice a week during second term.)

Text-book.— Hill's Jevon's Logic.

BOOKKEEPING.— This study is not required, but will be taught upon the application of at least five students for instruction therein. The course comprises principally Double Entry. Various kinds of business are represented, and all the modern conveniences and auxiliaries are explained and used. The student is required to finish at least six different sets of books. Those who complete these before the end of the term will be furnished with abundant material for further practice.

Grounds, Buildings and Equipment.

The grounds of the School of Mines are situated in the highest part of the town of Rolla, and are somewhat over twenty acres in extent. The recent purchase of the lot intervening between the Campus proper and the "Park" has united the holdings of the school into a single continuous tract. The buildings, which are all substantial brick structures, are: The Main Building, the Chemical Laboratory, the Mess Club House, and the Mining and Metallurgical Laboratory.

Important improvements have been made during the past year. The whole campus has been graded and sown in grass. A low stone wall, surmounted by an iron fence, has been constructed about the southern and eastern sides of the campus. New walks have been laid, and some new trees set out. The appearance of the grounds is a vast improvement on what would be inferred from the frontispiece to this catalogue. The old furnaces in the basement of the main building have been removed, and in their place has been installed a steam heating plant, which warms both the main building and the metallurgical laboratory. This takes steam from the two 35 horse-power boilers already in connection with the ore-dressing laboratory. By this economical arrangement steam for heating is kept up continually during the cold weather, and is drawn when needed to run both the large engine which operates the machinery in the mill and the small engine in the basement of the main building, which runs the dynamos and lathes.

In one of the basement apartments, formerly used for storage, a toilet room with laboratory and closets has been arranged. Water for this and other purposes is furnished from two compressed air tanks located in the basement, which are supplied by means of a windmill from a bored well, 180 feet deep.

Engineering Equipment.

The equipment for Field Practice includes a Heller and Brightly transit with solar attachments; a Gurley Construction transit; a Plane table with stadia attachments; a Gurley Y Level; a Buff and Berger Y Level; a Gurley Solar Compass; a Gurley Vernier Compass; two Sextants; a Lock Level, with the necessary Level Rods, Chains, etc.

Tests of cement are made with a Riehle Bros.' U. S. Standard Cement Testing machine. A Steam Calorimeter, a Thompson's Steam Engine Indicator, and a Dynamometer are used in the instruction in Steam Engineering.

The shop contains a Steam Engine, Metal Lathe, Wood Lathes, Benches for wood-work, and individual sets of hand tools.

Physical Laboratory.

The Physical Laboratory occupies three rooms in the main building and is well supplied with standard apparatus. Additions are constantly being made to its equipment.

The Dynamo Laboratory occupies a large room in the basement of the same building. It contains among other apparatus, a 60-light direct current dynamo, a Westinghouse Alternator and Transformer, a motor and standard measuring instrument both for direct and alternate current measurement. An engine and boiler are included in the equipment; also the necessary apparatus, such as indicators, calorimeters, etc., for complete engine and boiler tests. The work is so arranged that students become thoroughly familiar with the handling of apparatus such as is used in practical work.

A workshop, equipped with the necessary appliances for wood and metal working, is connected with the laboratory and gives students an opportunity to make whatever apparatus they may need in the pursuit of any original investigation.

Equipment in Mineralogy and Geology.

This includes a representative collection of 800 specimens of minerals for class use; 200 specimens of rocks; 150 specimens of typical fossils; a large collection illustrating metallurgical processes; a collection of 500 specimens of ore from the World's Fair. To this, additions are being made from time to time.

This material has been greatly augmented by the acquisition in 1895 of the entire Missouri Mineral Exhibit collected for display at the World's Fair at Chicago, which by act of the State Legislature became part of the permanent equipment of the School of Mines. This collection contains 3529 specimens representing the mineral wealth of Missouri, consisting of ores of lead, zinc, iron, and copper, coal, clays of many sorts, and building stones. Many of the specimens are of extraordinary size and rare beauty. The minerals occurring as gangue with the metalliferous deposits of the State are also well represented. Altogether it is an unusually valuable assemblage of geologic products of economic importance.

A full set of instruments for geological surveys constitutes a portion of the outfit of this department.

Mining and Metallurgical Laboratory.

The special building for the Department of Mining and Metallurgy has been finished, and equipped with the neces-

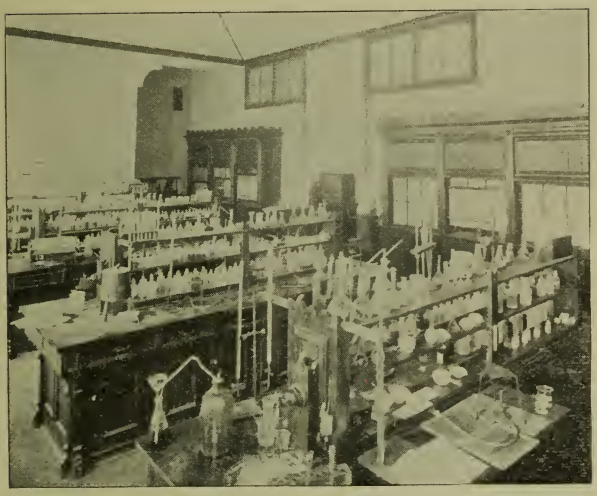
sary appliances for a practical course in ore concentration and reduction.

The building consists of two distinct portions, one containing a chemical and a blow-pipe laboratory, lecture room, reference library, draughting room, petrographical laboratory, blue print room, etc.; the other comprising a large mill room, an engine room, and a boiler room. The mill room is equipped with first-class modern machinery, of standard sizes, for crushing and concentration of ores, the plant containing a Dodge rock breaker, Cornish rolls, stamp battery with automatic feeder, Calumet hydraulic classifier. Hartz jig, Spitzkasten, Frue Vanner, grinding and amalgamating pan and settler, with settling boxes. In addition to these, working models of different types of concentrators have been made by students of the School of Mines and contributed to its outfit. The reduction plant consists of a reverberatory roasting furnace, and 20 inch water jacket cupola furnace, with Root blower, for lead and copper ores. There are also assay and cupellation furnaces, and before the beginning of next term a zinc distillation furnace, lixiviation, and gold chlorination plant, and other appliances will have been erected. The power for the above plant is derived from a 50 H. P. automatic engine; taking steam from two 35 H. P. tubular boilers.

By means of this excellent equipment students will receive practical instruction in the crushing and concentration of various ores, and in the metallurgical treatment of ores of lead, zinc, copper, gold, and silver.

There is much space remaining in the mill room which will be filed with additional appliances as rapidly as funds permit.

Chemical Laboratory.



The Chemical Laboratory is a substantial, well-lighted brick building, devoted entirely to the work of the Chemical Department. It contains a qualitative laboratory, quantitative laboratory, assay laboratory, lecture-room, preparation-room, balance-room, stock-room, private laboratory and office.

The qualitative laboratory is 47x25 feet and has working places for twenty-eight students at a time. The cupboards and drawers are duplicated throughout so that double that number can be accommodated.

The quantitative laboratory is to be enlarged before the next session. It will then be 47x27 feet and will have working places for twenty-six students. Its accommodations are excellent.

The assay laboratory is to be completely renovated before autumn. It will have concrete floors, will be properly ventilated and will be equipped with four muffle furnaces, besides one gasoline assay furnace carrying a 15x9 muffle, one small gasoline furnace with an 8x4½ muffle and one wind furnace in addition to apparatus for crushing, sifting and weighing the ore.

The balance-room is finely equipped with eight analytical and five assay balances. The equipment of the department is excellent and is being continually increased.

Library.

The Library contains 3,500 volumes. Good collections of works upon Engineering, Mathematics, Chemistry, Physics, Mining and Metallurgy afford to students in these

departments an opportunity to pursue an extended course of reading in connection with their class work. The Library also contains the standard works in English and American Poetry, Fiction, Biography, and History. It is well provided with encyclopædias and works for general reference. The Library is open and in charge of the Librarian from 8 : 30 A. M. to 12 : 30 P. M., and from 2 to 4 P. M. During these hours books may be taken out and the Library room used for reading and study. The following periodicals for the current year are found on the reading tables of the Library:—

American Geologist,
American Chemical Journal,
Annales de Chimie et de Physique,
Annals of Mathematics,
Century,
Chemical News,
Colliery Engineer,
Cosmopolitan,
Electric World,
Electrician (London),
Engineering ~~Magazine~~,
Engineering News,
Engineering and Mining Journal,
Forum,
Harper's Monthly,
Harper's Weekly,
Illustrated London News,
Journal of American Chemical Society,
Journal of Franklin Institute,
Journal of Iron and Steel Institute,
Ladies' Home Journal,
Life,
Literary Digest,
McClure's Magazine,
~~Mining and Scientific Press~~,
Nation,
North American Review,
Popular Science Monthly,
~~Power~~,
Scribner's Magazine,
Technology Quarterly,
Transactions American Society of Civil Engineers,
Wiedemann's Annalen,
Zeitschrift für analytische Chemie.

Mess Club House.

The "Club House," a three-story brick building of pleasing architecture, which has been in use only five years, has

recently been thoroughly repaired, cleaned, papered, and put into the best of order. It is at present conducted as a dormitory, solely, students lodging there and taking their meals at neighboring boarding-houses. Each room contains the simple, necessary furniture. Students furnish their own bedding and towels, and pay *pro rata* for the fuel consumed. Table board may be had in the vicinity for from $9.50 to $11 per month. No charge is made for room rent, but in order to engage quarters each applicant must deposit with the Treasurer of the School of Mines five dollars ($5.00), which shall be held as a contingent fund to pay for any damages for which the depositor may be responsible — the unconsumed portion of such fund being returned to him at the end of the session. Choice of rooms will be permitted in the order in which such deposits are received.

As the accommodations are limited, early application is advised.

General Information.

EXPENSES.

The School of Mines is endowed and supported by the State for the benefit of its sons and daughters, and seeks to offer to them its instruction at the lowest possible cost. It is believed that nowhere else in this country can equal advantages be had at such slight expense. The only fixed general charges are an entrance fee of $10.00 payable whenever the student may enter, and a library fee of $2.00 a term, payable at the beginning of each term. *There is no charge for tuition.* Students in the labora-

tories pay for apparatus damaged or destroyed; those in the chemical laboratory pay also for gas and fuel consumed and for chemicals used. To make this last item as small as possible, the School buys such supplies at wholesale rates and issues them to students as they are needed at corresponding prices. To cover bills arising from these sources students in Qualitative Analysis deposit upon entrance $10.00; those in Quantitative Analysis $15.00. These deposits must be renewed if at any time exhausted; at the end of the session whatever sum may remain to the credit of the depositor is returned to him.

No distinction in admission nor in charges is made between residents of this state and of other states and countries.

Board, including lodging, meals, fuel and lights, may be had in the Mess Club for from $11.50 to $13.00 a month; in private families for from $13.00 to $15.00; at the hotels for from $15.00 to $20.00. Washing costs from $1 to $1.50 per month.

Subjoined is an estimate of the necessary expenses for the school year:—

	Moderate.	Ample.
Entrance and Library Fees	$ 14 00	$14 00
Books, Stationery, Chemicals	15 00	50 00
Board, fuel, lights, washing	117 00	144 00
Total	$146 00	$208 00

EXEMPTION FROM FEES.

It is ordered by the Board that "all regular graduates of any department of the University, and every regular graduate of the Normal Schools established by law within the State, and the graduates of all other regularly chartered Literary and Scientific Colleges in this State, with regular

classes established therein, that are authorized by law to confer degrees and to grant diplomas to their students, shall be entitled to take *graduate* work in all the departments of the State University, including the School of Mines at Rolla, as Post-graduates, free of the payment of entrance fees."

By a similar resolution, teachers in Public Schools of Missouri will, *during the second term*, be admitted without the payment of any entrance fee. This privilege is granted to enable teachers, after their schools are closed, to utilize their time in self-improvement. The school looks for its reward to the eventual improvement of its entering students.

TERMS AND VACATIONS.

The college year is divided into two terms of nineteen weeks each. The first term begins on the third Tuesday in September, and ends about February 1. A ten days' vacation is given to include Christmas and New Year. There is no interval between the ending of the first term and the beginning of the second. Next session it is proposed to inaugurate a variation of work which may be regarded as a partial holiday. About April 1st, a week will be set aside in which there will be no recitations, but students will devote themselves to consecutive work in the various laboratories, the drawing-room, the shop, or to field excursions for practice in engineering or geology. The second term ends on Commencement Day, which is the second Thursday in June. The summer vacation extends from Commencement to the third Tuesday in September.

EXAMINATIONS.

In most of the classes there are daily oral examinations. Occasional written examinations on portions of subjects are

held. These are designed to give the students a review, to practice him in the writing of examination papers, and to enlighten the professor as to the progress of his class. From these sources the monthly grades are determined. At the end of each term searching written examinations on all the matter studied during the term are held. The marks gotten in these combined with the average monthly grades determine the "term grades." To pass, 75 per cent is required.

REGULATIONS GOVERNING EXAMINATIONS, DEFICIENCIES, ETC.

I. Special examinations in any study will be granted at the beginning of any term to new students seeking advanced standing, or to former students who may have failed to reach the passing grade in any subject, but whose average class grade in that study is as high as 50 per cent.

II. Students whose average class grade in any study is below 50 per cent will be required again to attend the class covering that subject.

III. No student may receive promotion from one class to the next higher class who is in arrears in work aggregating more than five hours of class exercises per week for the academic year.

IV. No student in a regular course will be allowed to take any work of the Junior year until he has completed all the requirements of the Freshman, nor to take any work of the Senior year until he has completed all the requirements of the Sophomore year.

V. A student who absents himself from the regular examination in any subject which he may be pursuing, will not be granted an examination in such subject except under condition of having pursued the same study with the next following class, unless such absence shall have been excused by the Faculty.

MONTHLY REPORTS.

Regular monthly reports are sent to the parents or guardian of each student, showing the student's grade in scholarship for the month and giving such other information in regard to his progress, attendance, etc., as may be thought of interest. The attention of parents and guardians is particularly called to these reports.

DISCIPLINE.

The School of Mines has but two general rules: 1. Be a gentleman (or a lady). 2. Work. Students who violate either of these are requested to leave. Flagrant violations of them are punished by suspension or expulsion according to the nature of the offense.

STUDENTS' SOCIETIES.

A general literary and scientific society composed of both students and professors, meets fortnightly to discuss topics of contemporary interest, important current events, scientific inventions and progress, etc. Lectures before this society are occasionally given by the professors. Advanced students in Chemistry have a "Journal Club" which devotes itself to the critical study of chemical articles of interest in the various publications relating to chemistry with which the Library is supplied.

The young ladies of the school conduct the "Alpha" Club, which meets weekly for literary cultivation and entertainment.

ATHLETICS.

Through the liberality of the Curators, an athletic field has been inclosed and graded for the benefit of the students. It furnishes ample space for base-ball, foot-ball and lawn tennis. An Athletic Association exists among the students, and foot-ball and base-ball teams and a tennis club are in organization.

ALUMNI ASSOCIATION.

An Association of Alumni of the School of Mines has been formed. Mr. Curtis Alexander (C. E. M. E., 1884), of

Argentine, Kansas, is its President, and Mr. Geo. R. Dean (B. S. C. E., 1891), of Kansas City, Mo., is its Secretary. Their first annual celebration will occur in Rolla, on June 10th, 1896. The programme upon that occasion will consist of an address of welcome from the Director, addresses or papers by the President, Mr. Alexander, Dr. Floyd Davis, Mr. Beauregard Ross, Miss Sallie Millard, and possibly others.

DEGREES.

UNTITLED DEGREES.

1. A Certificate of Proficiency is conferred on one who has attained the required standard in any of the following special courses: Assaying and Technical Analysis, Surveying, Electricity, Geology and Mineralogy, Inorganic Chemistry and Mathematics (through the Calculus).

2. A Diploma of Graduation is conferred on one who has attained the required standard in any of the following departments: Mathematics, Physics, Analytical Chemistry, Engineering, Mining and Metallurgy and the Academic Course.

DEGREES WITH TITLES.

1. The degree of Bachelor of Science in Mining Engineering, Bachelor of Science in Civil Engineering or Bachelor of Science in Chemistry and Metallurgy, will be conferred on one who has attained the required standard on all the subjects of instruction in Course I, Course II, or Course III.

2. The further degree of Engineer of Mines, Civil Engineer or Metallurgical Engineer, will be conferred on one who, having previously graduated in Course I, Course II, or Course III, has completed satisfactorily a year's post-graduate work in residence here, or who has had profes-

sional experience in a responsible position for not less than two years.

COMMENCEMENT.

The annual Commencement exercises are held in the Assembly Room on the morning of the final day of the session, the second Thursday in June. The exercises consist of the conferring of certificates, diplomas and degrees, the reading, when advisable, by the graduates, of abstracts of their theses, and an address by some prominent speaker. At the last Commencement the address was delivered by Hon. C. P. Walbridge, Mayor of St. Louis. The annual address of June 11, 1896, will be delivered by Hon. M. E. Benton, of Neosho, Mo.

At the last Commencement, June 13th, 1895, were awarded the following

CERTIFICATES OF PROFICIENCY.

GENERAL INORGANIC CHEMISTRY.

Anderson, P. B.	Dean, G. W.	Larsh, P. A.
Binns, F. J.	Donnelly, A. T.	Lewis, W. H.
Cameron, J. S.	Hallet, R. L.	Rogers, J.
Cox, J. C.	Kersting, F.	Torrence, L. C.
	Lacey, F. S.	

MATHEMATICS.

Eardley, A. E.		Kidd, G. C.

ASSAYING.

Buskett, E. W.	Gormly, S. J.	Spencer, H. G.
Donnelly, A. T.	Parker, D. T.	

SURVEYING.

Eardley, A. E.	Torrence, E. C.	Torrence, L. C.

MINERALOGY AND GEOLOGY.

Cowen, H. C.

DIPLOMAS OF GRADUATION.

ACADEMIC COURSE.

Godwin, A. G. Southgate, M. B.

MATHEMATICS.

Torrence, L. C.

DEGREES.

Bachelor of Science (in Chemistry and Metallurgy).

BUSKETT, E. W. DWYER, E. P.

Bachelor of Science (in Civil Engineering).

COWEN, H. C. KIRKHAM, J. E. FLORREICH, P.

Bachelor of Science (in Mining Engineering).

DYER, T. GORMLY, S. J.

Catalogue of Students.

SENIOR CLASS.

Martin, Walter Guy.....Muscatine, Iowa.
B. S., Purdue University, 1895.
Weissgerber, Otto.....Lebanon.

JUNIOR CLASS.

Anderson, Perry Barton.....Neosho.
Cameron, John Simpson.....Krebs, I. T.
Dean, George Walter.....Elk Prairie.
Donnelly, Arthur Thomas.....Rolla.
Kersting, Felix.....St. Louis.
Lacey, Ford Schell.....Neosho.
Larsh, Paul Armstrong.....Nebraska City, Neb.
Torrence, Euart Carl.....Pocahontas. 8

SOPHOMORE CLASS.

Barker, Ralph.....Chicago, Ill.
Beyer, Frank Bean.....Philadelphia, Pa.
Gottschalk, Victor Hugo.....St. Louis.
Groves, Virgil Pitzer.....Springfield.
Hanley, John Alexander, Jr.....Clayton.
Hendricks, James Otto.....Bolivar.
Kerr, William Christian.....St. Louis.
Knapp, Theron Lorenzo.....Rolla.
Lockridge, George William.....Jamesport.
Schofield, John Farrar.....Bolivar.
Soest, Walter Ernest.....Rolla.
Terrell, Arthur Davis.....Holden. 12

FRESHMAN CLASS.

Bowman, Wade Walbridge.....Lebanon.
Chamberlain, Santiago.....Monterey, Mex.
Fernandez, Abraham.....Monterey, Mex.

Graeser, Henry Jacob.....Stratmann.
Illinski, Alexis Xavier.....East St. Louis, Ill.
Jamison, Claude Eagan.....Rolla.
Knapp, Harlan Burr.....Rolla.
Lund, Albert Edward.....White Oaks, N. M.
Lund, Robert Ranous.....White Oaks, N. M.
Phariss, Bertie Lewis.....Rolla.
Regel, Ferdinand Herman.....St. Louis.
Rogers, Herbert Fordyce.....Holden.
Rolufs, Rulof Theodore.....Vest.
Sample, Charles William.....Pocahontas.
Tayman, Francis Joseph.....Lebanon.
Thomas, Paul Munson.....Rolla. 16

SPECIAL STUDENTS.

Cox, John Charles (*Surveying*).....Aspen, Colo.
Cox, William Rowland (*Electricity*).....Aspen, Colo.
Donnelly, Sophia Mary (*Chemistry*).....Rolla.
Donnan, David McAnally (*Electricity*).....Corydon, Iowa.
Flynn, Frank Nicholas (*Assaying*).....Aspen, Colo.
Fort, Edward Long (*Chemistry*).....Rolla.
Green, Albert Edgar (*Assaying*).....Chicago, Ill.
Hahn, Edward Louis (*Assaying*).....Muscatine, Iowa.
Lazarus, Harry (*Assaying*).....Durango, Colo.
Mason, Alfred (*Assaying*).....Gunnison, Colo.
Rebstock, Edward (*Mineralogy*).....Gwelo, Matabeleland, S. Africa.
Richards, Thomas Hanson (*Assaying*).....Riverton, Va.
Shimin, Edward Wheeler (*Assaying*).....Springfield.
Wood, Arthur Edward (*Chemistry*).....Rolla. 14

ACADEMIC STUDENTS.

Baxter, Clarence Gorden.....Canaan.
Baughman, Claude Griffe.....Rolla.
Burgher, Sylvia.....Rolla.
Elizondo, Julian.....Monterey, Mex.
Fraizer, Isaac Peter.....Rolla.
Heller, Miriam.....Rolla.
Hunt, James William.....Lenox.
Kissock, William Silas.....Maples.
Kline, Florence Irene.....Rolla.

McQueen, Phoebe Maud.....Rolla.
Millard, Anna Reed.....Rolla.
Millard, Linna.....Rolla.
O'Melia, Joseph.....Lebanon.
Powell, Walbridge Henry.....Rolla.
Richardson, Grace Sarepta.....Rolla.
Via, Jessie Miller.....Rolla.
Walker, Robert Franklin.....Rolla.
Watson, John Adolph.....Safe.
Westcott, Edith May.....Westcott.
Wilkins, Elinor Matilda.....Rolla. 20

SUMMARY BY STATES AND COUNTRIES.

Missouri	51
Colorado	5
Iowa	3
Illinois	3
New Mexico	2
Virginia	1
Pennsylvania	1
Nebraska	1
Indian Territory	1
Republic of Mexico	3
Matabeleland, S. Africa	1
Total	72

Graduates.

The following is a list of the graduates of the school, with some of the positions held since graduation, and their occupations and addresses according to latest information attainable. It is earnestly requested that Alumni will notify the Director of any change in location in time for the next catalogue.

1874.

Gustavus A. Duncan, C. E.— Assayer and Mine Superintendent, Colorado, '74–'82; Expert for Emery Bros., Minnesota; now Mine Owner and Examiner, Boston, Mass.

* John Holt Gill, C. E.

John W. Pack, M. E.— Assayer Boulder Smelter, Boulder, Colo., '74–'76; Assayer and Refiner, Montana and California. '76–'85; now Assayer U. S. Mint, San Francisco, Cal.

1875.

* Francis J. Deegan, C. E.— Engineer Louisville, New Orleans and Texas Railway.

Almon W. Hare, M. E.— Chemist and Assayer, Aspen, Colo.

1876.

Cyrus H. Emerson, C. E.— Denison, Tex.

Oscar E. Garvens, M. E.— With Vandalia R. R., East St. Louis, Ill.

John D. Greason, M. E.— Assistant Engineer and Right of Way Agent, D. M. and A. R. R.

* Dead.

John E. McGrath, C. E.— Assistant, U. S. Coast and Geodetic Survey, Washington, D. C. (recently in charge of Government Surveys in Alaska).

William C. Minger, M. E.— Assayer and Chemist in Colorado and, for one year, in Mexico, '76–93; now Analytical Chemist, Denver, Colo.

1877.

A. H. Ohmann-Dumesnil, M. E.— M. D., St. Louis Medical College, '80; Professor of Dermatology, Marion-Sims Medical College; Physician; Editor of St. Louis *Medical and Surgical Journal;* Author of several medical books and a large number of monographs.

Thomas H. Milsaps, C. E.

James A. Pack, M. E.— Assayer and Chemist, Butte, Montana; General Manager, Black Pine Mining Co.; Mine Engineer and Mill Superintendent, De Lamar Mining Co., De Lamar, Idaho.

1878.

* Wilton R. Brown, M. E.— Assayer, Shakespeare Gold and Silver Mining Co., Shakespeare, New Mexico,

William Y. Bean, C. E.— Engineer Missouri Pacific R. R.

*Lindsay L. Coppedge, C. E.—Engineer Missouri Pacific R. R.

Lee R. Grabill, M. E.— Assayer for Basic Mining Co., Rosita, Colo., '78–'82; Engineer for Gunnison Coal and Iron Co., Crested Butte, Colo., '83; since '83, Assistant Engineer in Government Work on Rivers and Harbors, Washington, D. C.

1879.

Rudolph C. Hoyer, C. E.— Draughtsman, U. S. Engineers' Office, Memphis, Tenn.

* Dead.

Charles F. Winters, M. E.— Formerly Assayer in New Mexico; now Teller, Los Angeles National Bank, Los Angeles, Cal.

1880.

Arthur Carson, M. E. — Chemist and Assayer, Butte, Mont.

Lorin X. Smith, M. E., C. E.—Div. Engineer K. C., Ft. S. and Gulf R. R. and same, Denver and New Orleans R. R.; Metallurgist for Flagler Reduction Works; Mill Superintendent, Seina Gravel Co., Lake Valley, New Mexico; Assistant City Engineer, San Diego, Cal.; Mill Superintendent, Hidalgo M. and M. Co., Parral, Mexico; Assayer, E. & E. Co., Baker City, Oregon; Assayer for Tiger & Poorman, Burke, Idaho; Chemist and Superintendent, Pioneer Sampling Works, Wallace, Idaho; Superintendent, and Mining Engineer, Bi-Metallic and Granite Mt. Cos., Philipsburg, Montana; Chemist, Colorado Smelter, Butte, Montana; now mining at Cripple Creek, Colorado.

Edward B. Summers, C. E.— U. S. Topographical Assistant '81–'85; R. R. Engineer, '85–'88; U. S. River and Harbor Works, '88–'91; with King Iron Bridge Co., '91–'94; now draughtsman, Bridge Department, New York Central and Hudson River R. R.

Walker W. Wishon, M. E., Chief Chemist, Montana Ore Purchasing Co., Butte, Mont.

1882.

Herman Neff Van Devander, C. E.—With St. Louis and San Francisco R. R., '82–'83; Engineer, Anniston and Atlantic Ry., '83–'84; Secretary and Treasurer Southern Mining and Improvement Co.; President and Treasurer North Georgia Mining Co., Cedartown, Ga.

Frank W. Gibb, C. E., M. E.— Mining Engineer and Chemist, now Architect, Little Rock, Ark.

W. P. Painter, C. E.— Editor *Democrat*, Carrollton, Mo.

Beauregard Ross, M. E.— Postmaster, Cameron, Mo.

Ashnah B. Schrantz, C. E.— Engineer Union Pacific Railway.

1883.

Floyd Davis, C. E., M. E.— M. Sc., Adrian College; Ph. D., Miami University; Prof. of Chemistry, Va. Agricultural and Mechanical College, '83–'86; Student Johns Hopkins University, '86–'87; Prof. of Chemistry, Drake University, '87–'93; State Chemist of Iowa, '88–'93; Acting Prof. of Metallurgy, Wisconsin University, and Commissioner for Iowa to Paris Exposition, '89; Prof. of Chemistry and Toxicology, Iowa College of Physicians and Surgeons, and Dean of Iowa College of Pharmacy, '91–'93; President New Mexico School of Mines, '93–'95; Author of several books and a number of scientific articles; now Analytical and Consulting Chemist, Des Moines, Ia.

1884.

Curtis Alexander, C. E., M. E. — Assistant Division Engineer Leavenworth, Northern and Southern Railway, '86–'87; Chemist for U. S. Antimony Co., '87–'88; Assayer and Chemist, Mexican Ore Co., Laredo, Tex.; Chief Assayer of Consolidated Kansas City Smelting and Refining Co., Argentine, Kansas.

William M. Claypool, C. E., M. E. — Chemist, Fairbank, Arizona; Manager, Arizona Ore Sampling Co., Prescott, Arizona.

Philip C. Gallagher, M. E. — Assayer and Chemist, Leadville, '84–'87; Superintendent Minnie Mine, Brecken-

ridge, Colorado, '87–'88; Assayer, Aspen, Colorado. Now at Leadville, Colo.

Arthur Neustaedter, M. E.— Office of Board of Public Improvements, St. Louis, Mo.; Supt. St. Genevieve Copper Works, St. Genevieve, Mo.; Chemist and Assayer, Butte, Montana.

Frank W. Wilson, C. E.— Draughtsman, Des Moines, Iowa, '84–'85; Transitman, C. R. I. & P. R. R., and C. B. & Q. R. R., '85–'86; Division Engineer, O. & R. V. Branch, U. P. R. R.; Transitman, St. L. & San Francisco R. R. '87; Superintendent of Construction, Atlanta Bridge Co. '88–'89; Chief Draughtsman, Milwaukee Bridge & Iron Works, '89–'90; Engineer, King Bridge Co., '90–'92; Assistant Engineer, Bridge Dept., N. Y. Central R. R.; now Engineer of Bridges, in charge of all bridge work on N. Y. Central and leased lines, New York, N. Y.

1885.

*John R. D. Owen, M. E.— Assistant in Chemical Laboratory, Missouri School of Mines.

Philip R. Van Frank, M. E.— Transitman, U. S. River Commission, Little Rock, Ark.

Fremont W. Wilson, C. E.— Resident Engineer, St. Louis, K. C. and Colorado R. R., '86–'87; Resident Engineer, Mississippi and Bonne Terre R. R., '88–'89; Assistant Chief Engineer, Middlesborough Belt Railway, Middlesborough, Ky., '90–'91; Division Engineer, Cauca R. R., U. S. of Colombia, '92–'93; Chief Engineer, Chicago, Indiana and Eastern Railway, Fairmount, Ind.

* Dead.

1886.

Jay Cullens, C. E.

Justo G. Martinez, M. E.— Assistant Chemist, Coahuila, Mexico; with Mexican International Railway; now Mine Operator at Guanacevi, Mexico.

James E. Fulcher, C. E.— Draughtsman M. P. R. R. and St. L. and S. F. R. R., '86–'87; Principal Aikinsville Institute, '88–'90; Prof. Natural Sciences and Mathematics, Nacogdoches University, Texas; Prof. Natural Sciences and Mathematics, McCune College, Louisiana, Mo.

G. W. Cole, C. E.— U. S. Coast Survey; Engineer, Mo. Pacific Ry.; now Second Lieutenant, Seventh U. S. Cavalry (by Presidential appointment), Fort Grant, Arizona.

Oscar Lachmund, M. E.— Chemist for Western Steel Co., St. Louis, Mo., 1887; Bullion Sampler for Holden Smelting Co., Denver, Colo.; with Grand View Mining and Smelting Co., Reid, Colo.; Assayer and Chemist for Idaho Sampling Works, Idaho City, Colo.

George B. Wiles, C. E.— With St. Louis Bridge & Iron Co., St. Louis, Mo.

W. Meritt Yeater, M. E.— City Engineer; Sedalia, Mo.

1890.

George Reginald Dean, C. E.— See 1891.

1891.

George Reginald Dean, C. E., B. S.— Assistant in Mathematics and Engineering Missouri School of Mines; Prof. of Mathematics, Maryville Seminary, Maryville, Mo.; Prof. of Mathematics and Engineering, Coe College, Iowa; Assistant in Leander McCormick Observatory, University of Virginia; Computer for J. A. F.

Waddell, Bridge Engineer, Kansas City, Mo.; Instructor in Mathematics, Central High School, Kansas City, Mo.

Sallie Elizabeth Millard, B. S. (in General Science).— First Assistant Vichy Normal Institute, Vichy, Mo.; Teacher, Carthage, Mo.

Frank H. Seamon, M. E.— Chemist and Assayer, Vacas Mining and Smelting Co., Mina de Vacas, Estado de Durango, Mexico; Chemist for Guanacevi Mining Co., Guanacevi, Mexico; Ore buyer for La Gran Fundicion Nacional Mexicana, Pachuca, Mexico.

Arthur J. Stewart, B. S.— Assistant in Chemistry, Missouri School of Mines; Assistant Superintendent Notalina Mining Co., La Noria, Estado de Zacatecas, Mexico; Chemist and Assayer, Guanacevi Mining Co., Guanacevi, Mexico.

1892.

Daniel C. Jackling, B. S.— Assistant in Chemistry, Missouri School of Mines, '92–'93; Chemist for Lawrence Gold Extraction Co., Lawrence, Colo.; Metallurgist and Mill Superintendent for the De La Mar Mines, Mercur, Utah.

Edward Mackay Johnson, B. Sc.— Chief Chemist for Kansas City Smelting and Refining Co., Argentine, Kan.

Fayette A. Jones, C. E., M. E.— Engineer for Union Mining Co., Phœnix, Arizona, '92–'93; Chief Engineer, New Mexico & Western Ry.; City Engineer, Independence, Mo., '94; Engineer for Old Mexico Land and Improvement Co., and Mexican Gulf Agricultural Co., Coatzocoalcas, Mexico; Consulting Engineer for the "Elephant Gold & Copper Co.," Office, Kansas City, Mo. and Gen. Manager & Engineer of the "Allen Gold

Mining, Smelting and Refining Co.," of Phœnix, Arizona.

Frank L. Tyrrell, C. E.-- See 1893.

1893.

Mary Page Buskett, B. S. (in General Science).— Teacher. Phelps Co., Mo.

John Calum Reid, M. E.— Draughtsman, Rolla, Mo.; Assayer for Kansas City Smelting and Refining Co., Argentine, Kansas.

Clifton Bates Spencer, C. E.— C. E. Cornell University, '94; now at Joplin, Mo.

Frank L. Tyrrell, C. E., M. E.— Assayer for Kansas City Smelting and Refining Co., Argentine, Kansas.

1894.

Theodore S. DeLay, B. S.— Assistant Professor of Chemistry, New Mexico School of Mines; Assayer, Victor, Colorado; Assayer for the I. X. L. Mining and Reduction Co., Swan, Colorado.

Temple Dyer, C. E.— See 1895.

Claude D. Grove, B. S. (in C. E. and M. E.).— Assayer for Lawrence Gold Extraction Co., Lawrence, Colo.; U. S. Dep. Mineral Surveyor — of firm of Mitton and Grove, Civil and Mining Engineers, Victor, Colorado.

George W. Herdman, C. E., Draughtsman in office of Mr. H. H. Hohenschild, Architect, Rolla, Mo. Transitman for Mr. C. W. Wells, Engineer, Victor, Colorado.

William S. Thomas, B. S.— Assistant in Chemical Laboratory, Missouri School of Mines, '95; Head Assayer, Anaconda Mining Co., Belt, Montana.

1895.

Evans Walker Buskett, B. S.— Chemist for Mound City Paint Works, St. Louis, Mo.

Herman Cyril Cowen, B. S.— Engineer (in charge of masonry construction) for the Stanwix Engineering Co., Schenectady, N. Y.

Edward P. Dwyer, B. S.— Chemist for Empire Zinc Co., Joplin, Mo.

Temple Dyer, B. S.— Lumber Merchant, Rolla, Mo.

Philip Florreich, B. S.— With U. S. River Commission, St. Louis, Mo.

Samuel James Gormly, B. S.— Professor of Mathematics and Engineering, New Mexico School of Mines, Socorro, New Mexico.

John Edward Kirkham, B. S.— Draughtsman for Mr. J. A. L. Waddell, Bridge Engineer, Kansas City, Mo.

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